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Selection of Best Lean Concept for Screw Manufacturing Firm using AHP

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Abstract—*Industries in the present time are competing with each other in order to increase, productivity, profits, and business. Lean manufacturing is beneficial for a manufacturing industry, many lean concept exist in present time. Different lean concept leads the manufacturing industries into a new direction. This paper present a case study of a screw manufacturing industry located at north of India (Sahibabad). In this paper basic purpose is to select the best lean concept for selected screw manufacturing industry, with the help of AHP (analytic hierarchy process). In this paper five different concept are chosen based on lean manufacturing, out of which only one, most beneficial to the industry is taken into account, calculated through AHP. The output from this paper is a lean concept which can be applied to the respective case study of a manufacturing industry to increase, profit, and productivity. Keyword - Lean concept, AHP, Global priority score.*

1. INTRODUCTION

Lean manufacturing is a systematic process to eliminate the waste (muda) and to increase productivity of an industry. In the present time a wide range of lean concepts could be found for an industry, lean concept used in a particular company is key source to eliminate waste and increase business. Using lean concept is a good move for an industry, but selection of best lean concept is also an issue. Problem in selection of lean manufacturing concept can be further solved by using AHP. AHP is known as analytic hierarchy process is a theory of measurement through pair-wise comparison and relies on the judgement of the experts to derive the priority scale. These scales measure the intangibles in relative terms. The comparison are made using a scale of absolute judgement that represent how much more one element dominates another with respect to the given attribute. The main concern of AHP is dealing with inconsistencies arising with the judgement and improving this judgement. In this paper, five different concept of lean manufacturing accounted, form which best one is selected with the help of AHP. In this paper a case study is done on a screw manufacturing industry located in north India (Sahibabad). These industries manufacture different size of screw. The manufacturing of screw follows some steps.

Firstly, wire is feed into machine, cutting of wire, heading of screw with the process of cold frodging as shown in figure 1, diesel oil is used for lubrication, headed screw is then transferred to a thread cutting machine, which also produce scrap material which can be used again to drawn into HHB wire as shown in figure 2. Different type of screw such as, combination Philip head screw, truss head screw etc as shown in figure 3. Industry accounted many waste in manufacturing of screw, which decrease industry productivity, increase in losses due to waste of scrap metal is not be used again to draw wire, diesel used for lubrication is not filtered properly before using again in machine this produce wear and tear in machine components and maintenance cost also increase. To eliminate these waste best lean concept selected through AHP is being used to increase productivity and profit of respective industry.

Fig. 1: Screw frodging machine

Fig. 2: Screw threading machine

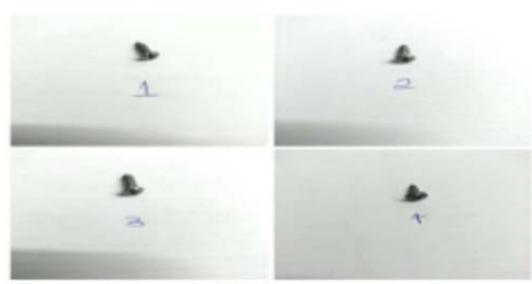

Fig. 3: Types of screw

2. CALCULATION FOR BEST CONCEPT

Five different concept based on lean manufacturing is been accounted for this case study. This concept selection is based on the different type of wastes taken into account at the time of case study. A lean manufacturing model with five enablers, ten criteria and 30 attributes was formulated. The five enablers are management responsibility, manufacturing management, work force, technology and manufacturing strategy. After this formulation of these attribute five concepts are taken for further calculation through AHP.

1. Concept A: Refinement of 5S policy
2. Concept B: Application of Continuous flow
3. Concept C: Use of Jidoka
4. Concept D: Use of Kanban system
5. Concept E: Reuse of Muda

Best concept is selected from these five concepts by the further calculation using AHP. These calculations are carried out in some process.

1. A pair wise comparison table 1 is formed between all the concepts. Pair-wise comparison between the concept is done by experts on the basis of some questions, these question help in pair-wise comparison.

- Which concept should be emphazied more in order to increase leanliness in industry?
- Which concept is relatively weighed more with efficient functioniory of the enablers?

Scaling is done between pair- wise comparison in which, 1 syands for equal imporatance, 3 for moderate importance, 5 strong importances, 7 very strong importances, 9 extreme importances.

Table 1: Pair wise comparison

	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	
A							*											B
											*							C
															*			D
							*											E
B															*			C
																	*	D
							*											E
C											*							D
					*													E
D							*											E

2. Formation of pair-wise comparison matrix A:

Concept	A	B	C	D	E
A	1	3	1/3	1/7	3
B	1/3	1	1/7	1/9	3
C	3	7	1	1/4	4
D	7	9	4	1	3
E	1/3	1/3	1/4	1/3	1

3. Build the normalized matrix A_1:

$$A_1 = \begin{pmatrix} a'_{11} & a'_{12} & \ldots\ldots\ldots\ldots & a'_{1n} \\ a'_{21} & a'_{22} & \ldots\ldots\ldots\ldots & a'_{2n} \\ \ldots & \ldots & \ldots & \ldots \\ a'_{n1} & a'_{n2} & \ldots\ldots\ldots\ldots & a'_{nn} \end{pmatrix}$$

And $a'_{ij} = a_{ij}/\sum^{n}_{i=1} a_{ij}$ for $i,j = 1,2,3,\ldots,n$

4. Calculate the Eigen value and Eigen vector

$$W = \begin{pmatrix} W_1 \\ W_2 \\ W_3 \\ W_4 \\ W_5 \end{pmatrix}$$

$$W' = AW = \begin{pmatrix} W'_1 \\ W'_2 \\ W'_3 \\ W'_4 \\ W'_5 \end{pmatrix}$$

And $W_i = \sum^{n}_{i=1} a'_{ij}/n$ for $i=1, 2, 3\ldots n$

$$\Lambda_{max} = 1/n\,(W'_1/W_1 + W'_2/W_2 + \ldots.. + W'_n/W_n)$$

Where W is the eigen vector,Wi is the eigen value of the given matrix and /\max is the largest eigen value of the pair-wise comparison matrix.

5. Check the consistency property: Table 2 shows a set of recommended random index (RI) values.If CR values aremorethan0.10for a matrix larger than 4£4, more than 0.08 for 4£4 matrices, more than 0.05 for 3£3 matrices, then it would be construed that the responses of decision makers is inconsistent. In this case, decision makers should revise the original values in the pair-wise comparison matrix. Table 4 present the CR value obtained during the conduct of this study. Since CR is less than 0.1, the comparison matrix shown is consistent. As the comparison matrices for detailed criteria were in accordance with their respective upper-level dimensions, their eigen vectors and consistent ratio were obtained. These values are presented in Table 4.

Table 2- Recommended value for random index

N	2	3	4	5	6	7	8	9	10
RI	0	0.52	0.89	1.11	1.25	1.35	1.4	1.45	1.4

Table 3- Calculated value for CI and CR

W	W'	$\wedge_{max} = 5.29$
0.2370	0.1187	CI= (5.29-5)/(5-1)
0.1996	0.0758	
0.1994	0.2482	CR= 0.0725/1.11
0.1996	0.5214	= 0.0653<0.1
0.1996	0.1111	

$$CI = (\wedge_{max} - n)/(n - 1) \text{ and } CR = CI/RI$$

Where /\max is the largest eigen value of the pair-wise comparison matrix and n is the matrix order.

6. The global priority table was formed to compute the global priority score. These global priority scores were obtained by summing up the product of weight of the concept alternatives with respect to the attributes and the local weights of the criterion and enablers. The mathematical formula used to determine the global priority scores is given below:

$$GPS_{ij} = \sum (CW_{ij} \times GW^{c}_{ij})$$

Where:

GPSij is the global priority score of the concept alternative CWij is the local weight of the concept alternative with respect to the attribute GWij is the global weight of criteria given by the product of the local weight of the criterion and the enabler.

7. The global weight and criteria and global priority scores of the different concept alternatives obtained during this case study are shown in Table 4, and 5, respectively. From Table 5, it could be found that concept E which is the reuse of Muda has the maximum global priority score.

Table 4- Values for local weight of enablers

S.No	Enablers	Local weight of enablers
1	Management responsibility	0.199
2	Manufacturing management	0.078
3	Workforce	0.471
4	Technology	0.199
5	Manufacturing Strategy	0.078

Table 5- Values for Global priority score

S.No	Criteria	Local Weight criteria	Global Weight criteria	Global Priority score
1	Organizational structure	0.255	0.054	(A)
	Nature of management	0.755	0.151	0.127
2	Change in business and technical process	0.838	0.614	(B)
	Streamlining of process	0.172	0.017	0.109
3	Employee Status	0.838	0.393	(c)
				0.265
4	Employee involvement	0.172	0.083	(D)
	Manufacturing setups	0.10	0.102	0.279
5	Manufacturing planning	0.10	0.102	(E)
	Status of quality	0.172	0.017	0.390
	Cost management	0.838	0.614	

3. RESULT OF THE STUDY

According to the above data and calculation during the case study of respective screw manufacture company, it is found that concept E that is "Reuse of muda" is calculated as best concept for the case studied industry, the following result is obtained by using AHP and with help of collected data of respective enablers, criteria, by which global priority score is determined and concept E has the maximum value for which it is considered as best concept for the respective company.

4. CONCLUSION

Productivity and profit of respective screw industry can be increased by concept E that is reuse of muda. This best concept calculated by method of AHP increase leanliness in industry. Reuse of muda is the process in which muda is generally considered as waste with no use to the customer prospective, but this muda (scrap metal, used diesel oil for lubrication) can be reused by proper treatment. Firstly, scrap metal can be drawn again into wire after require processing. Secondly, diesel oil after the use in machine can be cleaned again with the help of magnetic filter which will attract all the small scrap metal, further oil can be filter by settling process, so all the dirt can be settle down and oil can be used again for lubrication. The above discussed method will increase the productivity, leanliness and profit of respective industry.

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